2007

Broadcast and Banded Phosphorus and Potassium Fertilization for Corn and Soybeans Managed with No-Till and Chisel-Disk Tillage

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Abstract
No-till management results in little or no incorporation of crop residues and fertilizer into the soil. Subsurface banding of phosphorus (P) and potassium (K) fertilizers with planter attachments or before planting may be more effective than broadcast fertilization because both nutrients accumulate near the soil surface. A long-term study was initiated in 1994 to evaluate P and K fertilizer placement for corn and soybeans managed with no-till and chisel-plow tillage.

Keywords
Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences

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Introduction

No-till management results in little or no incorporation of crop residues and fertilizer into the soil. Subsurface banding of phosphorus (P) and potassium (K) fertilizers with planter attachments or before planting may be more effective than broadcast fertilization because both nutrients accumulate near the soil surface. A long-term study was initiated in 1994 to evaluate P and K fertilizer placement for corn and soybeans managed with no-till and chisel-plow tillage.

Materials and Methods

The study consists of four separate trials: P for corn, P for soybeans, K for corn, and K for soybeans. The experimental areas are on Galva and Primghar soils. Tillage and fertilization treatments are applied for both crops, and both are planted with a 30-in. row spacing. The cornstalks of plots managed with chisel-plow tillage are plowed in the fall and disked or field-cultivated in the spring. Soybean residue is disked or field-cultivated in spring. The planter is equipped with row cleaners and granulated fertilizer attachments. Fertilizer placement methods were broadcast, deep-band, or banded with the planter from 1994 until 2000, when the deep-banded treatment was discontinued. Results for all placement methods were summarized previously. This report summarizes results for the broadcast and planter-band methods.

Fertilizer for the broadcast treatment is applied in the fall and planter bands are applied 2 in. below and 2 in. beside the seed. Fertilizer rates for each placement method and nutrient have been a check, one-half the estimated annual maintenance rate (28 lb P_2O_5/acre or 35 lb K_2O/acre), and the maintenance annual rate (56 lb P_2O_5/acre or 70 lb K_2O/acre). Other treatments have been combinations of band and broadcast methods, the fertilizer maintenance rate for the 2-year rotation broadcast before one crop, and, since 2001, twice the annual maintenance rate broadcast each year. Results of these additional treatments are not shown because the effects on yield of corn and soybean were similar to those observed for the full annual P or K maintenance rates.

Results and Discussion

Deficient soil moisture (2001, 2002, and 2006) and heavy hailstorms (2004) reduced crop yield at the farm. Data for the dry years are included in the long-term averages shown, but hail-affected data from 2004 are not. Corn yields have been consistently more for chisel-disk tillage than for no-till for all treatments even in dry years (6 to 7 bu/acre more on average). However, the tillage system has not affected soybean yield.

Phosphorus fertilization has increased corn and soybean yields (Table 1), and responses have been similar for no-till and chisel-disk tillage systems. The large yield response to P is explained by low soil-test P in 1994 that decreased to the Very Low class for the check plots. In the early years of the study there were no differences between P rates. Since 2001, however, the annual 56-lb rate or twice this amount applied every other year has increased yield more than the 28-lb rate. The low P rate did not maintain soil-test P, whereas the 56-lb rate over-estimated the P maintenance needs and increased soil-test P to the Optimum class by the

late 1990s and to the High class by 2006.

Banded P has increased early growth of both crops more than broadcast P (data not shown). However, the P placement method has not affected grain yield of any crop for any application rate. Only recently has banding the lowest P rate been slightly better than broadcasting the same low rate.

Potassium fertilization has not influenced soybean yield and has had only infrequent and small effects on corn yield (Table 2). Small or no yield responses were expected in the early years because in 1994 soil-test K was in the High class, and levels in the check plots have decreased to the Optimum class. The 70-lb K rate was more than needed for maintenance and increased soil-test K levels over time. We have shown in previous reports that the small corn yield responses to K were observed mainly for no-till and for the deep-band placement method, which included a small effect of zone tillage due to planting corn on top of the knife tracks. Larger benefits of deep K were observed at other farms with lower soil-test K levels and for both corn and soybean. No advantage of deep banding has been observed for P. Those results, and similar ones for ridge-till, have resulted in the current Iowa State University guidelines for deep K banding for these tillage systems.

Conclusions

Soybean yield has been similar for no-till and chisel-disk tillage systems but yield of no-till corn has been lower over the years. Banding P or K fertilizer and high fertilizer rates have not consistently reduced this yield difference.

Phosphorus fertilization has produced large crop yield increases in this initially low-testing soil. A rate of 28 P_2O_5/acre/year maximized yield early, but a 56-lb rate or twice that amount applied every-other year maximized yield in recent years. Large effects of banded P on early crop growth translate into higher grain yield only for the lowest P rate and in recent years. Potassium fertilization with any placement method has resulted in infrequent and small yield increases because soil-test K has ranged from Optimum to High.

This work was funded, in part, by soybean checkoff funds from the Iowa Soybean Association.

Table 1. Phosphorus fertilizer effect on crop yield.

		Placement and lb P_2O_5/acre/year				
			Broadcast		Planter Band	
Period	Tillage	Check	28	56	28	56
		------ Corn yield (bu/acre) -------				
94-06	Chisel	122	146	153	148	154
	No-till	103	140	147	143	146
05-06	Chisel	139	180	190	182	191
	No-till	114	172	184	179	181
		----- Soybean yield (bu/acre) -----				
94-06	Chisel	37.2	44.2	45.5	44.8	46.2
	No-till	35.3	43.6	45.9	44.4	45.6
05-06	Chisel	47.0	58.0	60.0	60.5	61.0
	No-till	40.4	57.1	59.9	58.7	59.1

Table 2. Potassium fertilizer effect on crop yield.

		Placement and lb K_2O/acre/year				
			Broadcast		Planter Band	
Period	Tillage	Check	35	70	35	70
		------ Corn yield (bu/acre) -------				
94-06	Chisel	137	139	140	142	141
	No-till	131	134	133	131	133
05-06	Chisel	148	147	151	159	154
	No-till	144	146	144	144	143
		----- Soybean yield (bu/acre) -----				
94-06	Chisel	41.1	41.6	40.7	41.3	41.2
	No-till	41.2	42.2	41.6	41.4	42.3
05-06	Chisel	48.3	49.7	47.6	49.3	48.2
	No-till	48.2	51.3	49.9	48.6	49.9